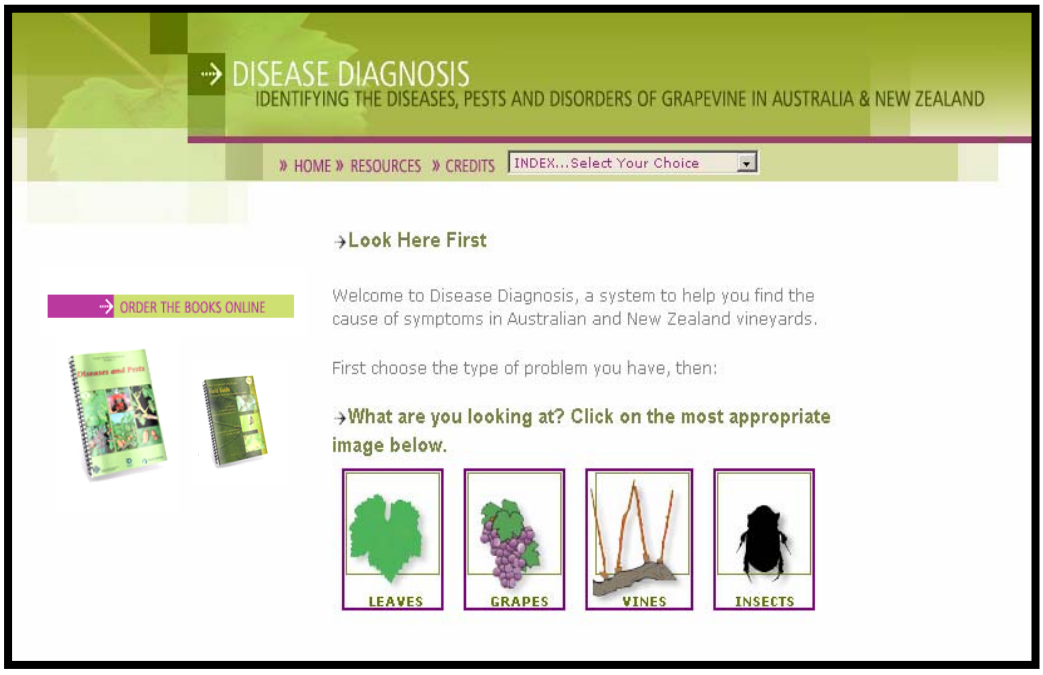
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Australian Government
Grape and Wine Research and Development Corporation

Digital Diagnosis of Vineyard Symptoms
- the *Disease Diagnosis* Module



FINAL REPORT to
GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION

Project Number: **SAR 02/08**

Principal Investigator: **PA Magarey**

Research Organisation: **SARDI**

Date: **September 30th 2004**

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ABSTRACT

A computer-based module known as ***Disease Diagnosis,*** has been prepared for grapegrowers to quickly and accurately diagnose symptoms of diseases, pests or disorders showing in the vineyard. Major features include: 1). more than 300 colour images, as presented in *The Australian and New Zealand Field Guide to the Diseases, Pests and Disorders of Grapes* (Magarey *et al,* 1999); 2). a *Look Here First* facility to help the user swiftly diagnose the broad nature of the symptoms in hand; 3). a *Looks Like* facility that leads the user through the array of images of similar symptoms; and 4) a series of text descriptions that give details of the symptoms, of the conditions under which they might develop and of how to monitor for the symptoms in the vineyard.

Disease Diagnosis has been designed for ease of use by the grower not used to computers or to accessing web-sites. Developed in the hope of encouraging grapegrowers become more familiar with the huge potential offered by the web as a source of electronically delivered technology (e-tech), ***Disease Diagnosis*** is a module ready for application in a comprehensive web-site for Australian growers. It is located within a web-site for grapegrowers at http://www.cropwatchonline.com.

EXECUTIVE SUMMARY

There is a trend within Australian communities for increased private use of web-based resources. This progress is similarly evident within viticultural communities as more growers use electronic-based technology (e-tech) on a regular basis. However, at present, the proportion of grape growers who regularly use the web is still low.

Reasons for this include a lack of useful web-based facilities that offer easy access to a broad array of information for growers, and many growers are not confident in using the web to get the information.

In attempt to overcome these deficiencies, a web-based product called ***Disease Diagnosis*** has been developed as a first module in a proposed web-site for Australian grapegrowers called CropWatch Online.

Disease Diagnosis allows grapegrowers to easily, quickly and accurately diagnose symptoms within vineyards of Australia and New Zealand. Based on more than 320-colour photos as published in the *Australian and New Zealand Field Guide to the Diseases, Pests and Disorders of Grapes* (Magarey, PA et al 1999), the module provides an e-tech version of that paper-based resource for growers. Simple diagrammatic keys in a *Look Here First* facility, swiftly directs users to the symptom type of their interest. Associated text notes assist diagnosis through written descriptions of the symptoms, the conditions under which they occur and how to search for them in the vineyard.

For example, a user of ***Disease Diagnosis*** wanting to determine the identity of a set of symptoms showing yellow spots on a grapevine leaf will be directed through *Look Here First* to the section within the module which contains a large colour photo and an associated 'family' of images (thumbnails) of the most frequent cause of yellow spots in a vineyard (in this case, paraquat weedicide damage). A *Looks Like* facility then provides the user with a second series of thumbnails that allows the user to view a variety of similar symptoms to compare with the initial array, ensuring rapid and accurate diagnosis.

The web-based module ***Disease Diagnosis*** has potential for immediate application as a resource for Australian grapegrowers and students of viticulture. It is ready for presentation within a pilot web-site for Australian grapegrowers known as CropWatch Online. That site (at http://www.cropwatchonline.com) provides a broad array of viticultural information initially based around the management of the diseases and pests of Australian vineyards.
That site links ***Disease Diagnosis*** with the GWRDC, Winetitles and SARDI home web-sites and allows web-masters at those sites to swiftly link to it.

GRAPE AND WINE RESEARCH AND DEVELOPMENT CORPORATION

FINAL REPORT
June 2004

Project Title	**Digital Diagnosis of Vineyard Symptoms**

Former title: **Diagnosis of Vineyard Symptoms Through Web Access to Existing and New Resources**

GWRDC Program Area 1 Innovation and Technology Adoption

ADMINISTRATION CONTACT (AC) DETAILS:

Title: **Ms**	First name: **Carmel**	Surname: **Larkin**
Research organisation and mailing address: **South Australian Research And Development Institute, GPO Box 1671, Adelaide SA 5001**		
Phone number: **08 8303 9307**	Fax number: **08 8303 9309**	Email and mobile number: **larkin.carmel@saugov.sa.gov.au**
Signature of AC		**Date**

PRINCIPAL INVESTIGATOR/S' (PI) CONTACT DETAILS:

Title: **Mr**	First name: **Peter**	Surname: **Magarey**
Research organisation and mailing address: **South Australian Research And Development Institute, GPO Box 1671, Adelaide SA 5001**		
Phone number: **08 8595 9111**	Fax number **08 8595 9199**	Email and mobile number: magarey.peter@saugov.sa.gov.au **0418 808 296**
Signature of PI		**Date**

Staff

Name	**Title**	**Position**	**Qualification**	**% of time to be spent on the project**
Peter Magarey	Mr	Senior Plant Pathologist	B. Ag. Sc. (Hons)	10

OBJECTIVES

To develop a prototype web-based system to allow Australian growers to diagnose symptoms of diseases, pests and disorders of vineyards.

Sub-aims:

1. To digitise the *Australian and New Zealand Field Guide to the Diseases, Pests and Disorders of Grapes* and incorporate it into or otherwise appropriately link the contents to the SARDI web-site;
2. To ensure the existing cross –reference system in the *Field Guide* is deployed to allow growers to easily compare and distinguish between similar symptoms;
3. To link the digital diagnostic system with web-sites at GWRDC and Winetitles to provide growers with coordinated remote access to rapid means of diagnosing field symptoms of diseases, pests and disorders; and in so doing;
4. To prepare an initial module of a web-based facility that will allow other 'electronic commodities' to be added, to assist growers access a broader array of web-based disease and pest management information.

BACKGROUND

The economic advantage of assured-quality grape products in the market place has increased the requirement for precision management of diseases and pests in Australian viticulture. Rapid and correct diagnosis of the symptoms of diseases, pests and disorders in the vineyard is fundamental to this, allowing optimum timing of spray applications. This enables effective control programmes with minimum chemical inputs - an output necessary for the precision demanded by the market place.

Early season control is important for the above to be achieved but that is when symptoms are less well developed and disease diagnosis is the most difficult.

Also, the relatively high number of new grapegrowers in Australia has meant that from a demographic viewpoint, the industry is relatively inexperienced in correct diagnosis of diseases, pests and disorders. To the contrary though, the advent of new growers has resulted in an industry with an increasing number of managers and field-based technical staff who are looking to use computer and web-based services for rapid access to the latest and best information. Thus it was timely for an innovative pilot-project to develop a web-based information centre for Australian grapegrowers beginning with the development of a digital diagnostic module.

The *Australian and New Zealand Field Guide to the Diseases, Pests and Disorders of Grapes* (Magarey *et al*., 1999. Winetitles, Adelaide, SA.) (the *Field Guide)*, is a paper-based publication that provides growers with colour photos and brief text statements about most symptoms found in the vineyard. The 327 digitised photos and brief text designed to help growers make correct diagnoses of the symptoms in their vineyard, provided a good basis for a web-site for office-based enquirers, especially the 'new generation' grapegrowers.

Conversion of the digitised photos and text would allow relatively swift development of the digital diagnostic site as first module in the proposed 'one-stop-shop' viticultural web-site. This web-site has potential to provide access to the best on-line diagnostic resources in a wide-array of other relevant viticultural information and services. Though initially to be used by only a relatively small proportion of growers, it is expected that its simplicity and ease of access will encourage the 'average' grower to 'have a go' at using the web-based diagnostic tool helping them become familiar with web-technology and gain confidence in its value to them as individuals. This should encourage the view that the web is a tool with vast potential to transfer of the latest technology - the resource needed for optimum precision in vineyard management.

It was envisaged that success in the development of the digital diagnostic module would catalyse the development of the larger viticultural web-site. Design of the framework for the larger site would then be needed and additional modules added to extend the service. Later, the library of photos of in-field symptoms in the diagnosis module could be added to, as could disease-assessment and spray residue-assessment keys and an unlimited host of additional viticultural service modules *eg* for irrigation, soil and nutrition etc.

Thus, the present project was intended as a first step in catalysing a wider web-based system for the 'average' Australian grower over the next five years, to provide remote access to information and services leading to the adoption of the latest viticultural technology. By including best-practice management of diseases and pests in a timely and efficient manner, this technology would assist the production of the highest quality grape products for our markets.

METHODS AND RESULTS

Design

The computing aspects in the development of the web-site module were undertaken through Michael Major from *win@biz*, Adelaide, the web-site division of Winetitles, the publishers of the *Field Guide*. This collaboration allowed maximum efficiency in developing the site through ready access to existing electronic versions (images) of the 327 photographs in the *Field Guide* and their associated captions and text. The copyright holders, SARDI and Winetitles, made these available to the project.

The module, called ***Disease Diagnosis***, is designed as an online diagnostic tool for grapegrowers and vineyard managers. It was purpose-built for ease and consistency of use by growers unfamiliar with using the Internet. Text and visual cues within ***Disease Diagnosis*** help growers diagnose a set of symptoms or identify an insect specimen.

The data and descriptions included for each disease, disorder or insect include:

- Name of the disease, disorder or insect, plus one full-size image
- A brief description (~50 words)
- Where it occurs (eg shoot, leaves, bunches etc)
- When it occurs (eg spring, autumn)
- 'Look for' - a bullet list of symptoms and how to detect them in the vineyard
- Images - a family of up to 10 images with captions for each (see later for a description)
- 'Looks like' - links to up to five similar symptoms each with links to up to five additional symptoms (see later for a description).

Compatibility

Because out-dated (superseded) computer and web-based browsers are still in widespread use, the content and function of ***Disease Diagnosis*** was designed to (where possible) assist access by the 'average grower'.

Future Modifications

The majority of the content was written in database format so that the module can be maintained and updated with comparative ease. This will permit alterations by the simple edits to the content of an MS Access® database and uploading those revisions to the appropriate web-server.

Components

The images in ***Disease Diagnosis*** are arrayed in a co-ordinated and cross-linked series of colour images of most of the diseases, pests and disorders that a grower is likely to encounter in Australian or New Zealand vineyards. It includes the photos and text published in the *Field Guide*. The images are initially arrayed as 'thumbnails' (small versions of the photo files) displayed using minimum RAM (the computer's capacity to 'think').

Presentation of ***Disease Diagnosis*** and of the steps required to access various aspects of the component modules, is presented more fully in the following description and figures.

Level 1: '*Look Here First*' Initial Diagnostic

Upon entering ***Disease Diagnosis***, users are presented with a small array of diagrammatic symptoms **(Figure 1)**. These comprise line diagrams of a leaf, a bunch, a shoot and an insect. That view allows rapid segregation of symptoms or specimens of each basic type.

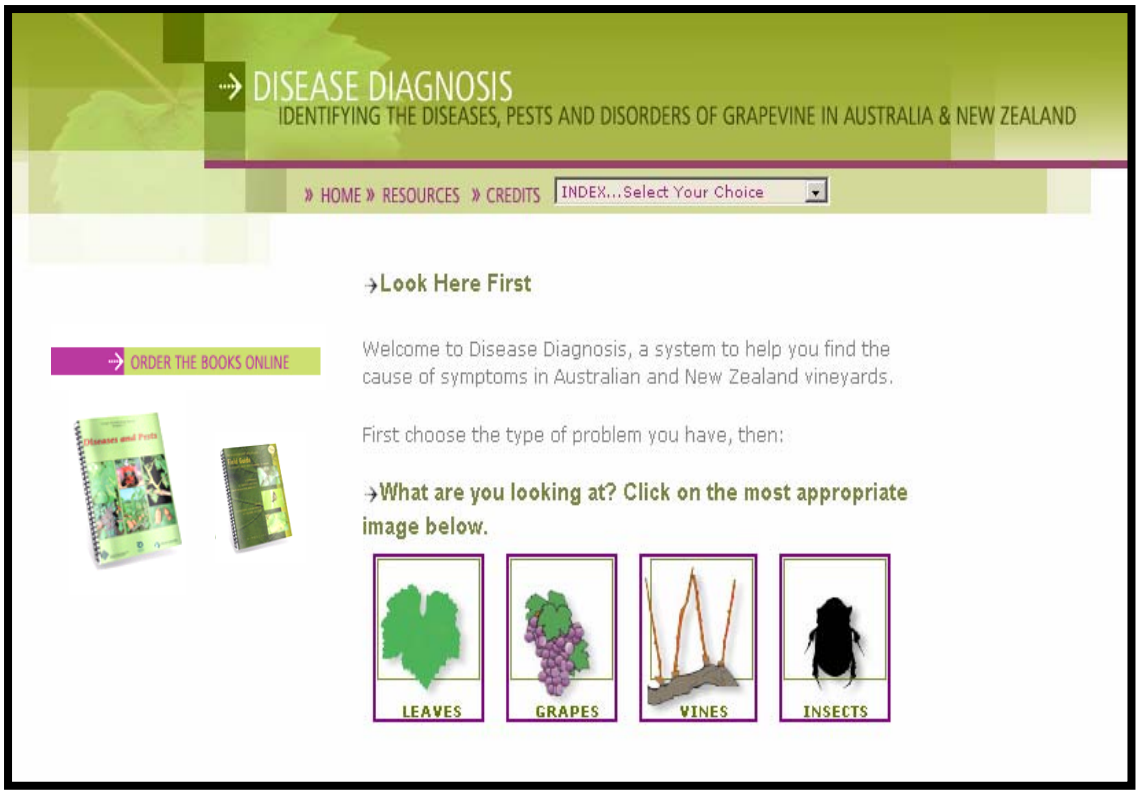


Figure 1. Front screen of *Disease Diagnosis*, a web-based system for growers and technicians to diagnose the diseases, pests and disorders of grapes in the vineyards of Australia and New Zealand.

By clicking on any diagram, the user is taken to Level 2 in the module.

Level 2: 'Look Here First' Second Stage (Figures 2a – 2d)
A new array of diagrams is then presented. At each level in the array, both a drawing and a thumbnail image of the disease, disorder or insect is presented as in the 'wordless index' at pp. 4 and 5 of the *Field Guide*.

The user then sees one of the following array of diagrams:

Diseases and Disorders
Leaves

- Leaf with yellow spots
- Leaf with white spots
- Leaf with brown spots
- Leaf with yellow veins
- Leaf with brown margins

Bunches

- Bunch with brown berries
- Bunch with grey-white coating

Shoots

- Cane with white patches
- Cane with red patches
- Vine with dead spur or arm

Insects and Pests

- Small green grub
- Fluffy white bug
- Small brown dome
- Big brown or green grub
- Spider
- Moth
- Weevil
- Beetle
- Wasp
- Snail

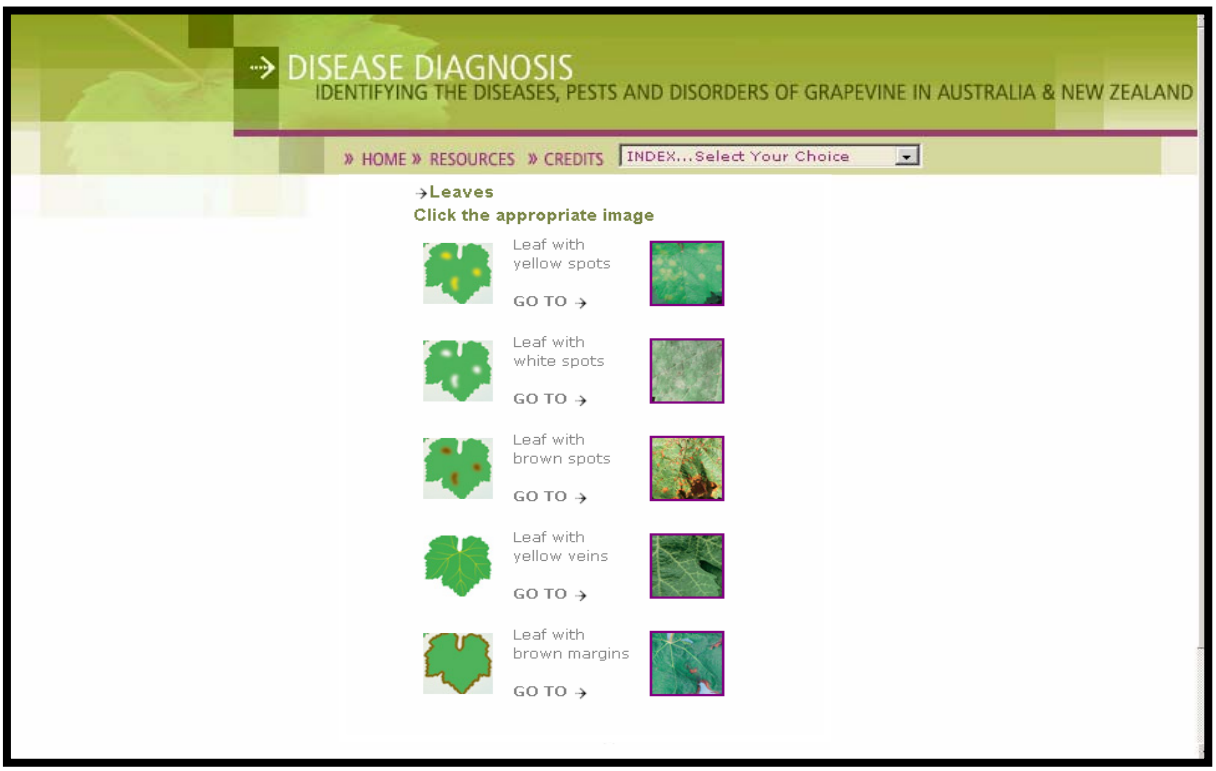


Figure 2a. Second level screen of ***Disease Diagnosis*** showing the quick reference section which directs users to the family of **leaf symptoms** found most frequently in vineyards. This allows most rapid progress in diagnosing these symptoms.

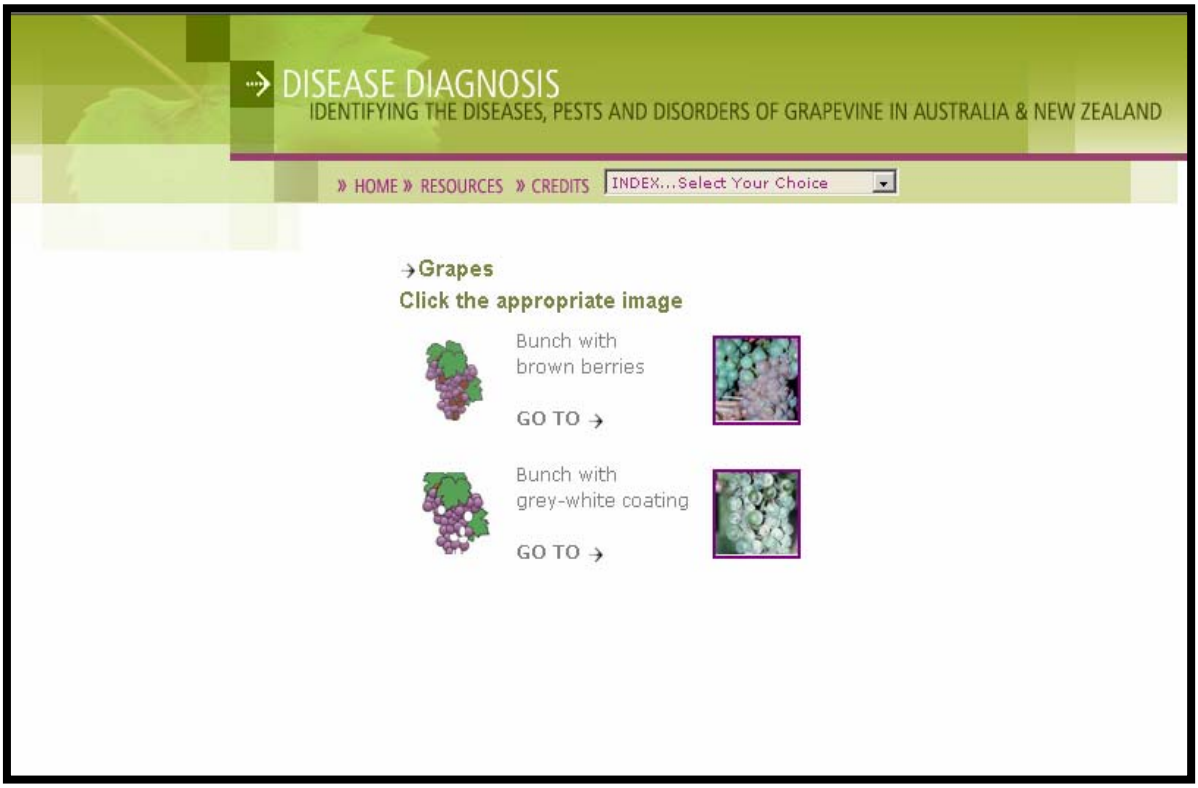


Figure 2b. Second level screen of ***Disease Diagnosis*** showing the quick reference section which directs users to the family of **bunch symptoms** found most frequently in vineyards. This allows rapid diagnosis of symptoms on bunches.



Figure 2c. Second level screen of ***Disease Diagnosis*** showing the quick reference section which directs users to the family of **shoot** symptoms found most frequently in vineyards. This allows most rapid progress in identifying symptoms on shoots.

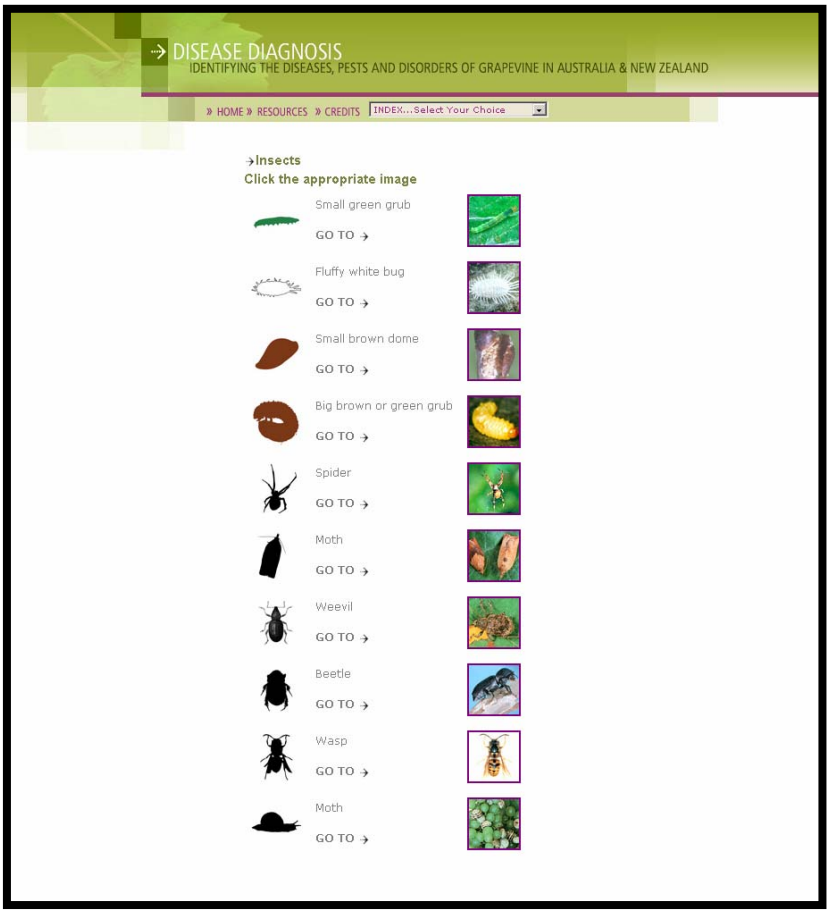


Figure 2d. Second level screen of ***Disease Diagnosis*** showing the quick reference section which directs users to the **insects** found most frequently in vineyards. This allows most rapid progress in their identification.

To access an item of interest, users may double-click any thumbnail to the right of the relevant diagram. This opens the third level of ***Disease Diagnosis***.

Level 3: Diagnosis of pest, disease or disorders (Figure 3)
A new series of linked-thumbnails are opened at this level. Each image is presented in a 'family group' listed at 'OTHER (images)' comprising all other photos available for that particular subject.

For example in Figure 3, all the photos from the *Field Guide* that portray downy mildew on leaves, are presented as a 'family' of thumbnails from that location. One key photo from each family is expanded to full size for clear viewing while the rest of the family are presented below the heading 'OTHER FOLIAR BURN IMAGES' as thumbnails for quick comparison.

Level 3 consists of pages of symptoms under the following headings:

Diseases

- Downy mildew
- Powdery mildew
- Botrytis
- Other bunch rots
- Phomopsis
- Black spot
- Eutypa
- Black goo
- Other trunk diseases
- Crown gall
- Nematodes
- Root rots
- Fanleaf and Rugose wood virus
- Leafroll
- Yellow speckle
- Australian grapevine yellows
- Late season leaf curl

Insects and Pests

- Lightbrown apple moth
- Mites
- Mealybug
- Snails
- Scale
- Weevils
- Minor leaf and bunch pest
- Boring Insects
- Phylloxera
- Birds
- Beneficial insects

Disorders and injuries

- Nutritional disorders
- Fungicide damage
- Herbicide damage
- Weather damage
- Mechanical damage
- Other things

Disorders and injuries

- Quarantine diseases and pests

Looks Like series for rapid diagnosis (Figures 4 & 5)
A second order series of thumbnails is arrayed with the family photos (as at LOOKS LIKE in Figure 3). This second series comprises thumbnails of ***Looks Like*** images that illustrate symptoms likely to be confused with the family of photos presented for that topic. The ***Looks Like*** function is used throughout the module and allows users to follow a series of similar images with ease. This function allows the user to cycle through all similar photos comparing and contrasting images prior to settling on a diagnosis. Quicker and more accurate diagnosis will result and importantly, the user will have confidence in the outcome.

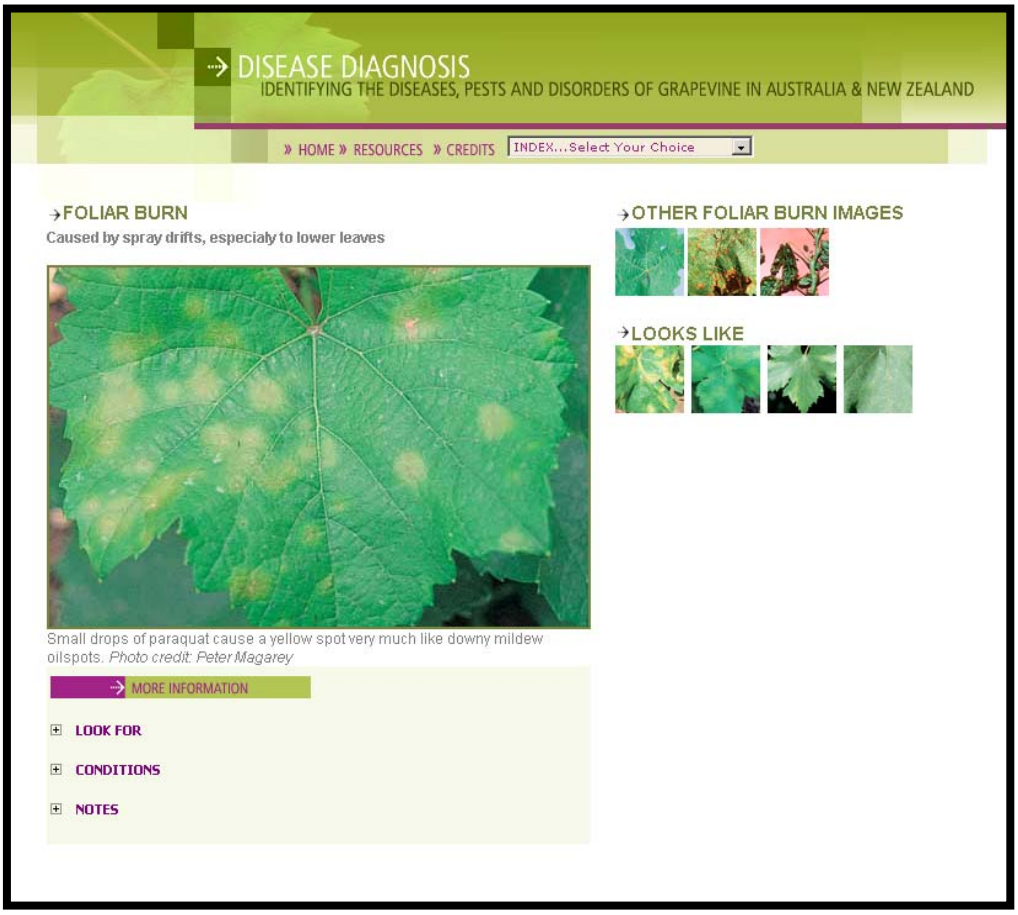


Figure 3. Third level screen of ***Disease Diagnosis*** showing **quick diagnosis section.** A fully expanded image of paraquat weedicide damage shows the most frequently observed cause of yellow spots on leaves. Beneath that photo is the family of 'OTHER …' images of symptoms caused by paraquat which allow cross-checking of similar symptoms. The family of *Looks Like* photos presents the symptoms most likely to be confused with the above. The user can fully expand all these thumbnails simply by double-clicking the image.

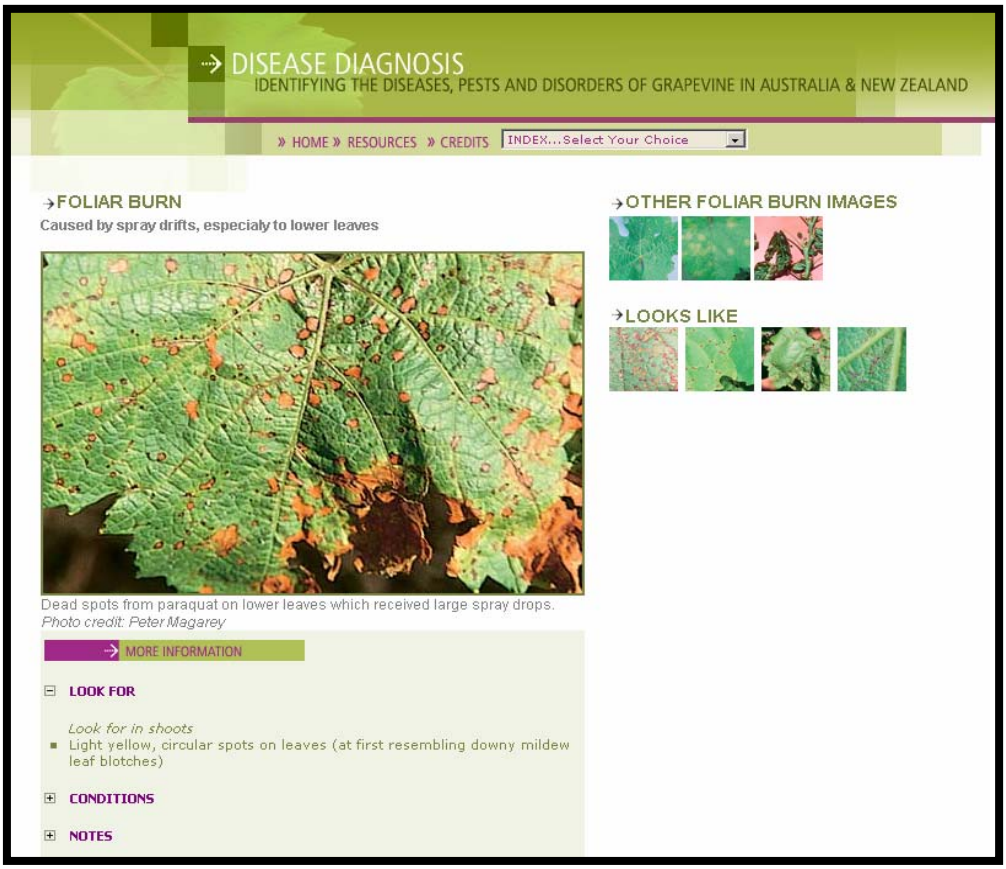


Figure 4. Third level screen of ***Disease Diagnosis*** showing the result of clicking on the central image of the 'OTHER FOLIAR BURN' thumbnails as seen in Figure 3, to expand the image in full. Note: The new array of ***Looks Like*** thumbnails is now presented for the new image.

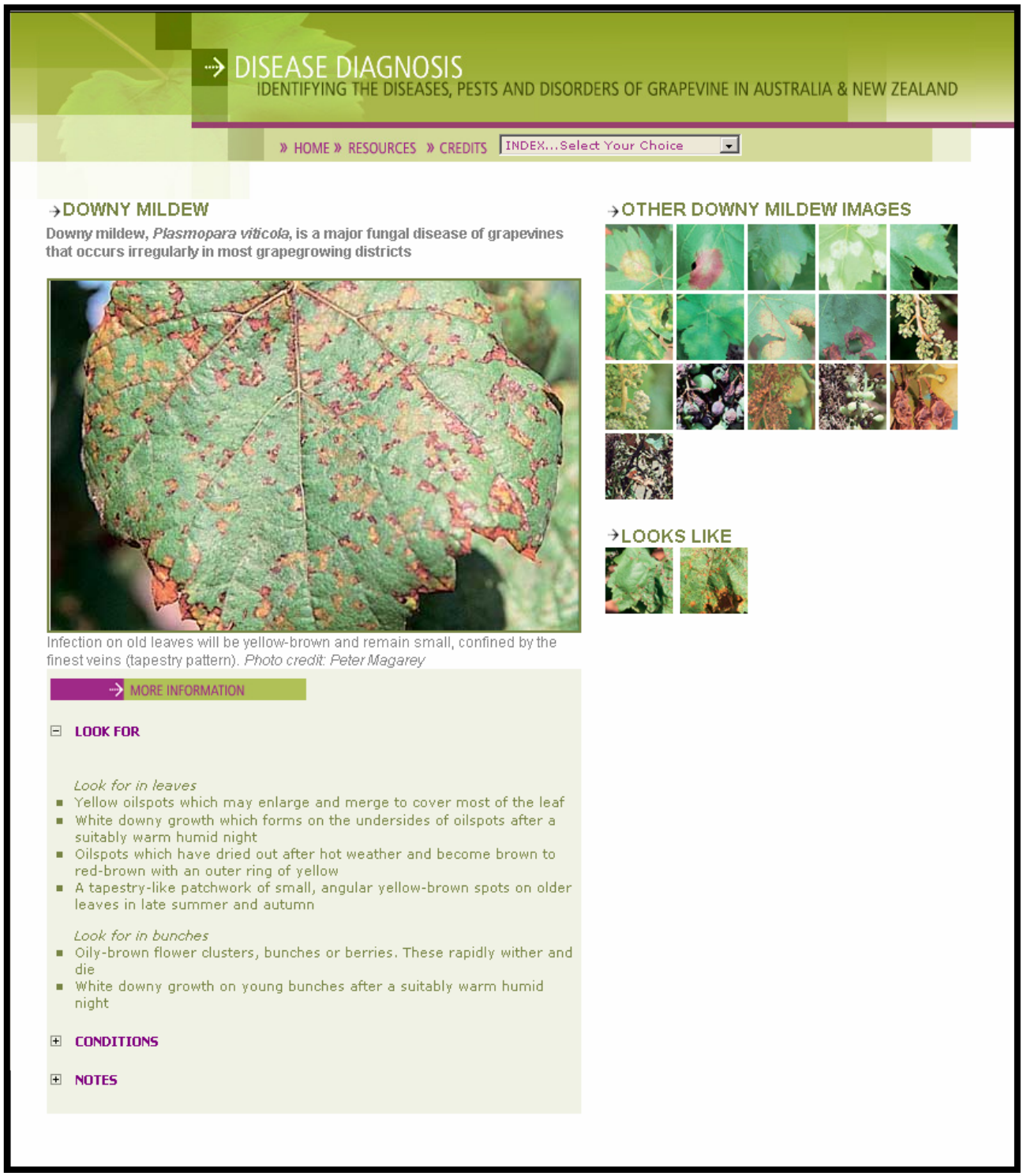


Figure 5. Double-clicking the left-hand ***Looks Like*** thumbnail as presented in Figure 4, opens the downy mildew family of images in ***Disease Diagnosis.***

Note: 1. The main ***Looks Like*** image is fully expanded, in this case, showing downy mildew.

2. The user has also clicked on the ***Looks Like*** and **Conditions** buttons on the left-hand side of the display in Figure 4, to display the detailed text-descriptions about the subject in this case, downy mildew.

DISCUSSION

Disease Diagnosis was completed to a level exceeding the limits of the project finances. This was made possible by *win@biz* voluntarily contributing more time to the project than contracted, reflecting their interest in the project.

Present Status

Disease Diagnosis currently offers growers a ready and speedy link to more than 320 colour images representing a wide array of symptoms found in Australian and New Zealand vineyards.

Designed for easy access by growers to diagnose these symptoms, ***Disease Diagnosis*** uses a fast-track facility called ***Look Here First*** (Figures 1 & 2a-d). This takes enquirers to the symptom most frequently encountered in each symptom type, in many cases, resulting in immediate diagnosis. A series of three text-categories presented for each image at checkpoints called *Looks Like*, *Conditions* or *Notes* provide written descriptions of various aspects of each disease, insect or disorder describing their symptoms, the conditions which favour their occurrence or how to scout for them in the vineyard. These serve as independent avenues to correct diagnosis.

The family of 'Other …..' images presented for each symptom (Figures 3 & 4) shows the array and variation in the expression of most diseases, pests and disorders eg the developmental stages of powdery mildew symptoms on leaves. This family of images provides users with perspective for surety in diagnosis. In addition, the ***Looks Like*** series of images (Figures 4 & 5) cross-references and cross-links the user directly to similar symptoms likely to be confused with those presented on-screen at any one time. This series allows comparison (and contrasting) of images with similar symptoms throughout the module, strengthening the accuracy of diagnosis and helping users to simply and correctly arrive at the final diagnosis.

Since the present site only facilitates diagnosis and does not provide information on how to control diseases, pests or disorders, users are guided on-line to further information in the publications *Diseases and Pests, Grape Production Series No. 1* (Nicholas *et al.*, 1994) and the *Field Guide.*

Modification

Disease Diagnosis has been assembled in database format to allow optimum presentation of the colour images in a single-viewing page. This presents a large image in consistent format (along with the 'Other …..' and ***Looks Like*** series of images) for greatest access by growers from their home computers while retaining capacity within the module for easy addition, modification and/or replacement of the contents if desired. This permits change of images or text with speed and will allow the module to be improved and expanded on a continuing basis.

Present Application

Since the subject of ***Disease Diagnosis*** is principally symptoms and these change little over time (since there is no information on disease or pest control), the contents of the module are expected to be substantially stable. None-the-less, it is expected that the present array of images and text will have an unlimited need to be reviewed and improved as additional images are sourced and new text clarified. However, the existing module contains sufficient images to adequately portray most diseases and pests and adequate text to provide users with a valuable and highly usable resource for immediate use.

Several options exist in the way ***Disease Diagnosis*** may be deployed. These include:

1) incorporating ***Disease Diagnosis*** into an existing web-site;
2) establishing the module as a stand alone web-site; or
3) establishing a new web-site to include ***Disease Diagnosis*** within that site.

Since ***Disease Diagnosis*** was constructed in database format (to allow users best access to the colour images), this has precluded introducing the module to some existing web sites including the SARDI's. Also, the module would not appear to provide a sufficient resource on its own to warrant a stand-alone web site, especially so being new and relatively unknown to growers at present. However, ***Disease Diagnosis*** has been constructed as a module ready to be included in a broader based web site that would provide a multi-disciplinary array of viticultural information to Australian grapegrowers. It is recommended that this option be pursued (see below).

Introducing Disease Diagnosis to Australian grapegrowers

Industry context: Web-based tools are no longer the technology of the future - they are resources for today used in many facets of community-life eg banking and commerce and to an increasing degree, agriculture. There are a growing number of web sites for grapegrowers to access information relating to day-to-day management of vineyard problems in Australia. However, the level of adoption of electronic-based technology (or e-tech), is still proportionately low.

To illustrate this, 70% of 622 Riverland grower-registrants of CropWatch request weekly dispatch of the message by fax whereas 30% request e-mail delivery. The balance is different in McLaren Vale where 24% of 218 growers request fax delivery and 76% request e-mail messages. This reflects the demographic difference between the two regions in part contributed in McLaren Vale by there being more vineyard owners that live and are employed off-site than in the Riverland. While in regions like Sunraysia a much lower rate of adoption may be expected, the balance across Australia is likely to be similar to the Riverland profile.

Encouragingly, the level of adoption of e-mail services in Riverland CropWatch has increased from ~15% five years ago. This trend reflects the increased adoption of computer-based services across the Australian community as well as in our viticulture. As a result, given that e-mail usage has preceded the use of the web as a source of viticultural information and is increasing steadily, the introduction of web-based services is expected to increase as useful sites become increasingly available. It is likely that Australian growers will progressively access this e-tech although those in regions such as McLaren Vale might be relatively fast adopters of these services compared to regions like the Riverland and Sunraysia.

One factor contributing to the low level of adoption of e-tech in viticulture is the lack of useful web services for growers. Few provide a broad-array information with daily relevance for growers, as distinct from narrow-range web services *eg* from specific chemical companies. Importantly though, evidence suggests that as more growers become familiar with use of the internet and better e-tech services are made available, the demand for quality information relevant to Australia will catalyse the use e-tech in Australian viticulture.

Timing: The development of ***Disease Diagnosis*** would appear to be well timed for two reasons: 1). it provides growers with a web-based means of diagnosing disease –complementing the paper-based version of the *Field Guide*; and 2) it is an easy-to-use means of encouraging growers to become familiar in using web-based services - this in anticipation of an increased number and application of such services in the next few years.

Disease Diagnosis is thus ready as a simple tool to allow growers to diagnose disease symptoms from a distance and to catalyse their use of web-based resources. In encouraging growers to use the web, ***Disease Diagnosis*** should help reduce the time lag for the benefits of powerful e-tech to be realised more fully in Australian viticulture.

In addition:

- The present *Field Guide* has sold in excess of 5,000 copies throughout Australia signifies the interest growers have in diagnosing vineyard symptoms;
- In the same way as full-coloured publications for diagnosing diseases and pests *eg GPS 1 Diseases and Pests*, and the *Field Guide*, have taken precedence over two-toned or black and white, paper-based publications, CD's *eg* Bug Match – Grapes™, and other e-tech services will become a regularly used viticultural resource;
- The increasing number of growers who use e-tech facilities means that it has been timely to prepare an electronic version of the *Field Guide* to introduce Australian growers to using computers to diagnose disease;
- Australian grapegrowers have a reputation for adopting new technology - thus there is good potential for ***Disease Diagnosis*** to be adopted if packaged appropriately;
- Despite this, it is unlikely that e-tech will exclude the use of quality paper-based publications. In fact, current trends suggest that e-tech and paper-based publications will serve as complementary tools meeting the differing needs of individuals whether the user is located 'in-the-field' or 'in-the-office';
- For in-field use, it seems unlikely that e-tech publications will compete significantly with use of the *Field Guide* until hand-held computer technology has merged more fully with mobile phone technology, reducing their price and advancing their function;
- A number of international web sites present some information on disease and pest management for grapegrowers, indicating that a well-presented module such as ***Disease Diagnosis*** will gather support and be used by grapegrowers in this country (and beyond).
- The layout and presentation of the *Field Guide* provided a useful foundation for the development of ***Disease Diagnosis***. Since little design change was needed in the paper-based file to prepare the present product, cost-efficiencies were significant in the present project.

CropWatch Online ™

Disease Diagnosis has been prepared as a module for inclusion in web sites such as CropWatch Online ™. In a separate initiative, that new site has been developed to a level ready for test-implementation in 2004/05 as part of the delivery of the regular CropWatch service in both the Riverland and McLaren Vale, SA. CropWatch is an industry-based service that provides growers with weekly messages relating to the current options in managing the diseases and pests in their vineyards. CropWatch Online™ will allow growers in both Riverland and McLaren Vale to access the latest CropWatch messages 24-hr/day, 7 days/week and will provide a broad-array of additional viticultural information in a format easy to access.

CropWatch Online ™ (at http://www.cropwatchonline.com) contains cross-links to many viticultural agencies including industry bodies such as the GWRDC's web site. Since ***Disease Diagnosis*** has already been incorporated as a functional module, it will also provide growers with access to diagnosing disease and pest symptoms in their vineyards.

The development of CropWatch Online ™ thus serves in fulfilment of sub-aims 3 and 4 of the present project *viz:* to cross-link ***Disease Diagnosis*** with web-sites at GWRDC and Winetitles to provide growers with coordinated remote access to rapid means of diagnosing field symptoms of diseases, pests and disorders; and in so doing, to prepare an initial module of a web-based facility that will allow growers to access a broader array of disease and pest management information.

Potential for adoption by industry

The initial number of growers who access ***Disease Diagnosis*** will be somewhat limited as for most web-based tools. However, it would appear that just as the adoption of the fax machine, e-mail and mobile phones began in slow fashion but then increased dramatically, so it is expected that Australian grapegrowers will soon be looking for and accessing other e-tech such as web sites. The controlling factors in the above cases were a combination of function and price. When ease of use allowed the 'average' person to access this technology such as mobile phones, the rate of use increased dramatically. As consumer use-rates increased, a reduction in price led to further increases in their use. It is anticipated that growers will find ***Disease Diagnosis*** easy to use. Its access at low-cost, through CropWatch Online ™ should increase the rate of its adoption.

The main risk of failure relates to a possible lack of grower adoption of web-based technology in preference to more traditional methods of technology transfer. The main factor influencing this will be personal attitude toward computer systems rather than the cost of such systems – the older aged grower will naturally have more reservations and some, a phobia, against computer-systems (though equally, some are aged high-rate users of e-tech). Future growers will, in general, be more familiar with computers and the potential they offer. Notwithstanding, historically Australians have shown an high rate of adoption of (useful/practical) new technology.

Another factor that may limit adoption of ***Disease Diagnosis*** is 'line speed', that is the rate at which home computers can access web-servers at a distant site. This will limit the speed at which images within ***Disease Diagnosis*** can be accessed on home computers and may discourage some growers from using the module. However, with the introduction of broadband and other improved electronic communication services, this problem can be expected to decline in the next few years. As an example, broadband communications which assist the use of facilities such as ***Disease Diagnosis***, is already available in country towns like Loxton in the Riverland.

A third possible limitation relates to the capacity of the user's computer. Factors include the size of the computer screen and amount of RAM (read only memory) which translates to the capacity of the computer to access and display images.

However, the objective of the project has been to develop an easy-to-use module to encourage home-based growers to access web-based technology. ***Disease Diagnosis*** has been designed with these limitations in mind allowing for simplicity and attractiveness to grapegrowers even if aged equipment is being used. Computers with 64Mb RAM and screens with display areas of 640 x 480 pixels can access ***Disease Diagnosis***. Most growers have (much) more modern systems than this and so will have an excellent display.

Benefits to industry

Several benefits are expected:

- Australian growers will have at least two different types of tool to diagnose symptoms in their vineyard: a) through use of the hard-copy, in-field version of the *Field Guide*; and b) through use of the web-based ***Disease Diagnosis***. This flexibility is expected to meet the need of growers who have different preferences and skills, to make easy but correct diagnoses using the diagnostic tool of their choice;
- The introduction of CropWatch Online ™ as an attractive, user-friendly web-based service to assist growers access information on a variety of viticultural management issues will lead to more growers using e-tech systems and so accessing additional information relevant to them. For example, in the form of CropWatch Online ™, ***Disease Diagnosis*** is complemented with a system that provides information on disease and pest alerts and management recommendations (as given by CropWatch SA™) and a huge array of additional information, for example, including weather forecasts.
- Also, CropWatch Online ™ has capacity for the presentation of addition text and/or images, allowing access to this information as supplied by research, extension or industry-based personnel. This facility provides for the dispatch of relevant in-field photos and text concerning symptoms/issues of immediate local importance. For example, images of sunburn or frost events, local disease outbreaks or notification of local field days etc. This will assist and could confirm, diagnosis of symptoms in a grower's own vineyard.
- Correct and early diagnosis of symptoms in the vineyard can save entire crops from destruction, if for instance, downy mildew is wrongly assumed absent from the vineyard at early season in a wet spring. Access to ***Disease Diagnosis*** and its use leading to correct diagnosis, has the potential to avoid crop losses from such events.
- Early diagnosis will contribute to the need for fewer sprays and better control achieved for vineyard diseases and pests leading to lesser impact on the environment in the long term.
- Future development may allow incorporation of the AusVit™ Companion Series CD-ROM from CRCV Technologies into the ***Disease Diagnosis*** module as appropriate.

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